NASA SP-5016

# TECHNOLOGY UTILIZATION REPORT

## Technology Utilization Division





# A Technique for JOINING AND SEALING DISSIMILAR MATERIALS

*From*
LEWIS RESEARCH CENTER
Cleveland, Ohio







NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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## SUMMARY

During cryogenic research at NASA's Lewis Research Center, a boltless attachment and sealing method was conceived and used. The method features configured male and female members with a third material in the resulting cavity. Under the NASA Technology Utilization Program, this fastening method has been studied for potential use in industrial products and processes. The study has revealed that the basic concept can provide the basis for a family of fastening and sealing methods. Representative areas of design use are presented and investigatory activity suggested.

## THE BASIC CONCEPT

At the NASA Lewis Research Center, a novel attachment and sealing method was conceived during cryogenic research directed toward evaluation of the stress distribution near abrupt changes in wall thickness of pressure vessels. The attachment was used to fasten and seal pressure vessels at the seam between a cylinder and a head. The initial design was for high-pressure use over a range of temperatures from $70^{\circ}$ F to $-452^{\circ}$ F.

The basic concept is shown in figure 1. It features an annular reentrant cavity which is filled to an appropriate level with a low-melting-point alloy composed of bismuth, lead, tin, and antimony. This alloy was selected because it expands on cooling to perform both the holding and sealing functions. Significant features of this joint construction are:

(1) ease of assembly and disassembly by simply heating the joint above the melting point of the alloy which does not form a wetted bond

(2) reusability of the individual components

(3) effectiveness of the pressure seal

(4) minimum induced stress in the cylinder component

(5) the ability to connect dissimilar materials

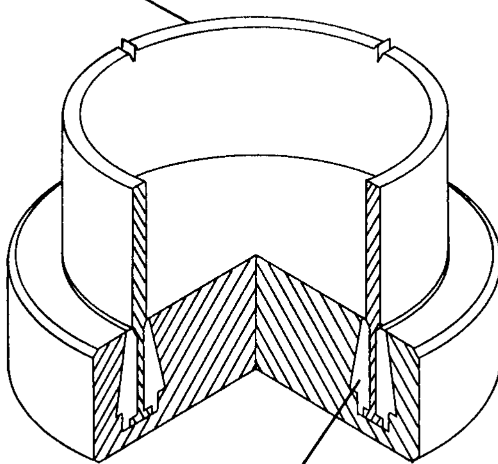


Figure 1.--Original design as used by NASA.

In the research program, many applications of the principle have been used and tested. The seal has proved quite reliable in cryogenic applications at pressures up to 2000 psi.

## APPLICATIONS

The boltless attachment and pressure seal concept has proved to be of such great value in research at Lewis that it appears that the concept and variations based on it could have major value to the industrial community as well. A somewhat similar general method of joining metals has been used industrially for such applications as mounting of rule-die blades in the boxboard industry and the completion of joints in conventional sewer pipe. With this known, the most obvious application of the new concept is in the manufacture and testing of tanks. Less obvious, however, is expansion of the concept to achieve a broad family of positioning, joining, and sealing applications based on this "formed cavity and third material" concept.

The initial concept with the low-melting-temperature material in the boundary area limits application to cryogenic and room temperatures uses. If the principle is expanded to include usable alloys which have higher melting temperatures or to the use of nonmetals like epoxy resins or liquid elastomerics like polyurethane, the application possibilities become extremely broad. It is with these possibilities in mind that the following illustrative ideas for use of the fastening method are presented. The order of presentation of these examples of types of application has no significance.

## Pressure Vessel Construction

Pressure vessels for handling gases and liquids at cryogenic temperatures are a continuing problem to industry. In the concept illustrated by figure 2, the boltless attachment is used to effect fabrication of a vessel which might have improved reliability in containment and increased ease of assembly. The ability to design for minimum induced stress might also reduce manufacturing costs from a materials standpoint.

This product idea is the most obvious extension of work performed at Lewis.

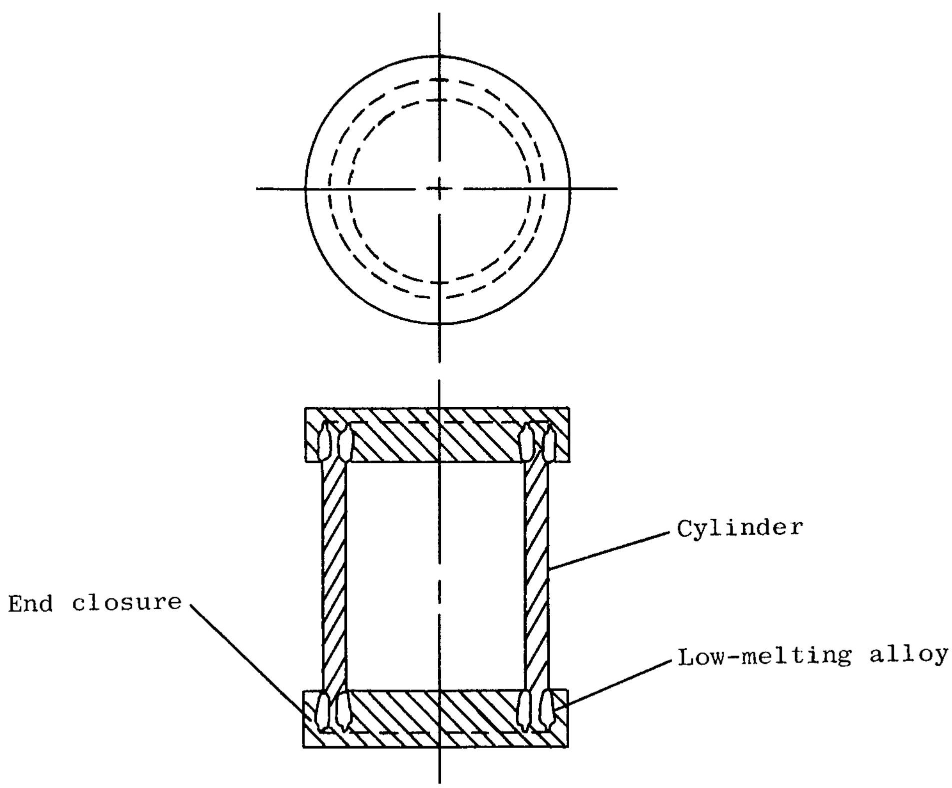


Figure 2.--Pressure vessel.

## Concentric Pipe

Figure 3 is a schematic drawing of a concentric or jacketed pipe system that would allow the joining of pipes in locations where it might be difficult or impossible to glue, braze, solder, or weld. In this system, the joints could be heated without the necessity of access to the inner joint. If materials like the epoxies were used in the joint, the necessity for heat would be eliminated.

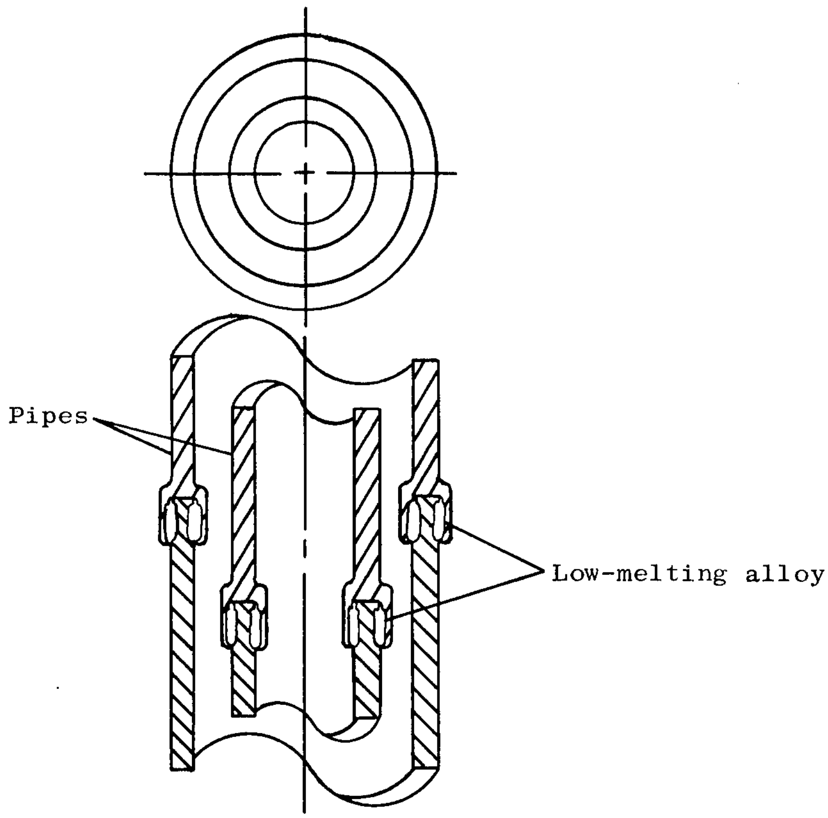


Figure 3.--Concentric pipe assembly.

## Structural Seam

In both the building and construction areas, the joining of both similar and dissimilar materials is a major problem. There is a need for convenient methods of forming seams which are both structurally sound and vapor-tight. This is particularly true in the modern curtain-wall and window-wall construction used on high-rise buildings. It is also important in the construction of truck trailers, house trailers, and railroad cars.

Figure 4 is a schematic drawing of two ways in which this fastening method could be used in construction. Joint A is configured for completion of a seam between sheets of relatively thin structural material. The matrix material, probably a thermosetting plastic, would be injected after location of the parts relative to each other and would form both a permanent fastening and a vapor seal. Joint B has a configuration more closely related to that shown in the original concept. It would be used for fastening relatively heavy members and could be considered for use in load-bearing structures.

A.

B.

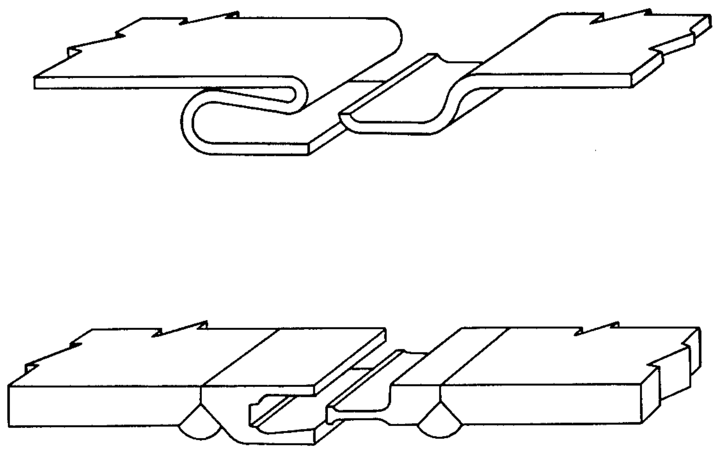

Figure 4.--Seams.

## Encapsulation

In general, when materials are to be evaluated in irradiation experiments, the materials are encapsulated in order to control environment and to eliminate hazards associated with uncontrolled particulate and gaseous material. Both encapsulation and the opening of capsules after irradiation are expensive and time-consuming tasks.

Figure 5 is a sketch showing how the fastening and sealing concept could be adapted for use in a capsule. The capsule could take the form of a cup with a female groove in the lip. The groove would be filled to an appropriate level with matrix material which could be heated by induction or other appropriate means while the lid is placed in position. Subsequent to irradiation and by remote handling at the hot cell, the capsule could be brought to an elevated temperature which would permit simple lifting and removal of the lid. This concept would be appropriate for use in cold-wall capsules.

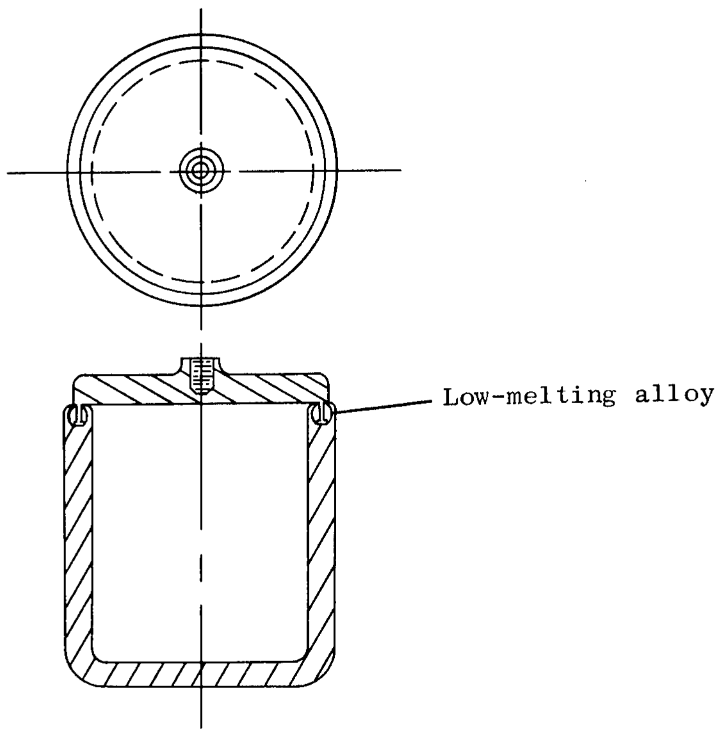


Figure 5.--Encapsulation method.

## Work Holders

Use of the basic concept at Lewis was directed toward holding a thin-walled cylinder with minimal induced extraneous stresses. This use suggests an area of further application in the metal-working industries. In many cases, it is important that a part be turned or ground to small wall thicknesses with no error induced by clamping forces, vibration, or thermal effects. Figure 6 shows the concept utilized as a holding fixture for precision cylindrical grinding. Two such devices could be used for grinding between centers.

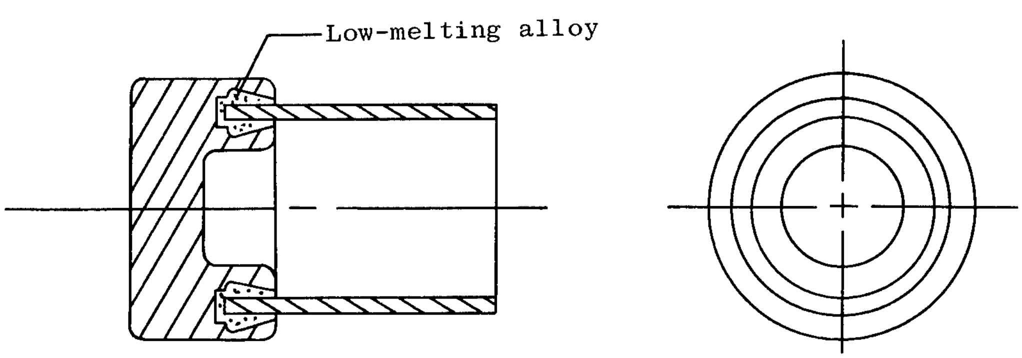


Figure 6.--Chucking method for precision work.

## Alignment Method

Figure 7 is a schematic drawing of a fastener designed to permit leveling or alignment of joints. The configuring of this fastener in uniform convolutions permits the insertion of the pin, leg, dowel, or other member to any desired depth during the last operation of assembly of a product. One merit of this application of the matrix material idea is that the system can be freed and adjustments in the amount of projection can be made conveniently. A different design would be required if such a joint were subject to tension or torsion.

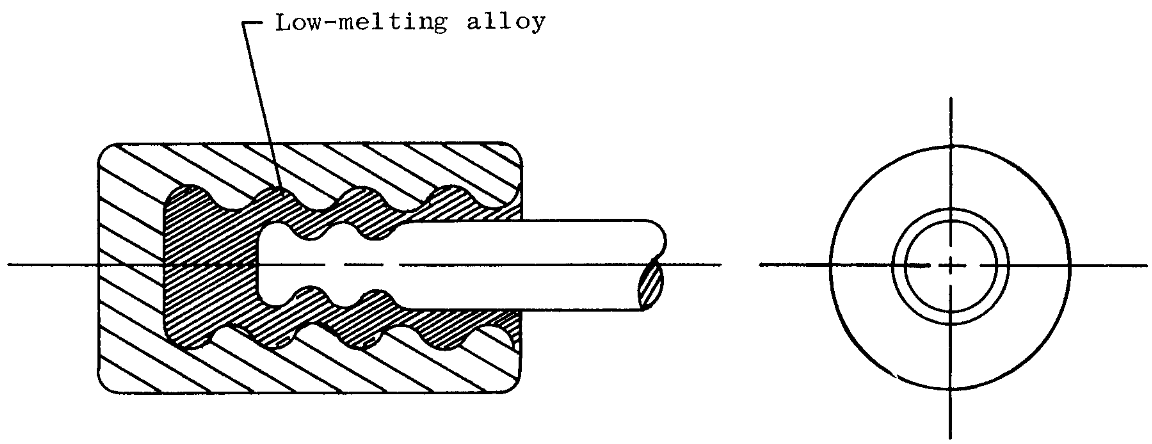


Figure 7.--Alignment mechanism.

## Plastic Pipe Union

In many applications of the basic design configuration, the introduction of an intermediate matrix material is quite difficult, if not impossible. Figure 8 shows a pipe joint before and after it is "made". In this design, the thermoplastic pipe is heated by the metallic receiver, and longitudinal force is applied until both cavities flow full of pipe material.

From this conceptual drawing one can visualize a second generic family of fasteners in which the male member is caused to flow by heat, chemical action, or mechanical working to form fastening and sealing between two dissimilar materials.

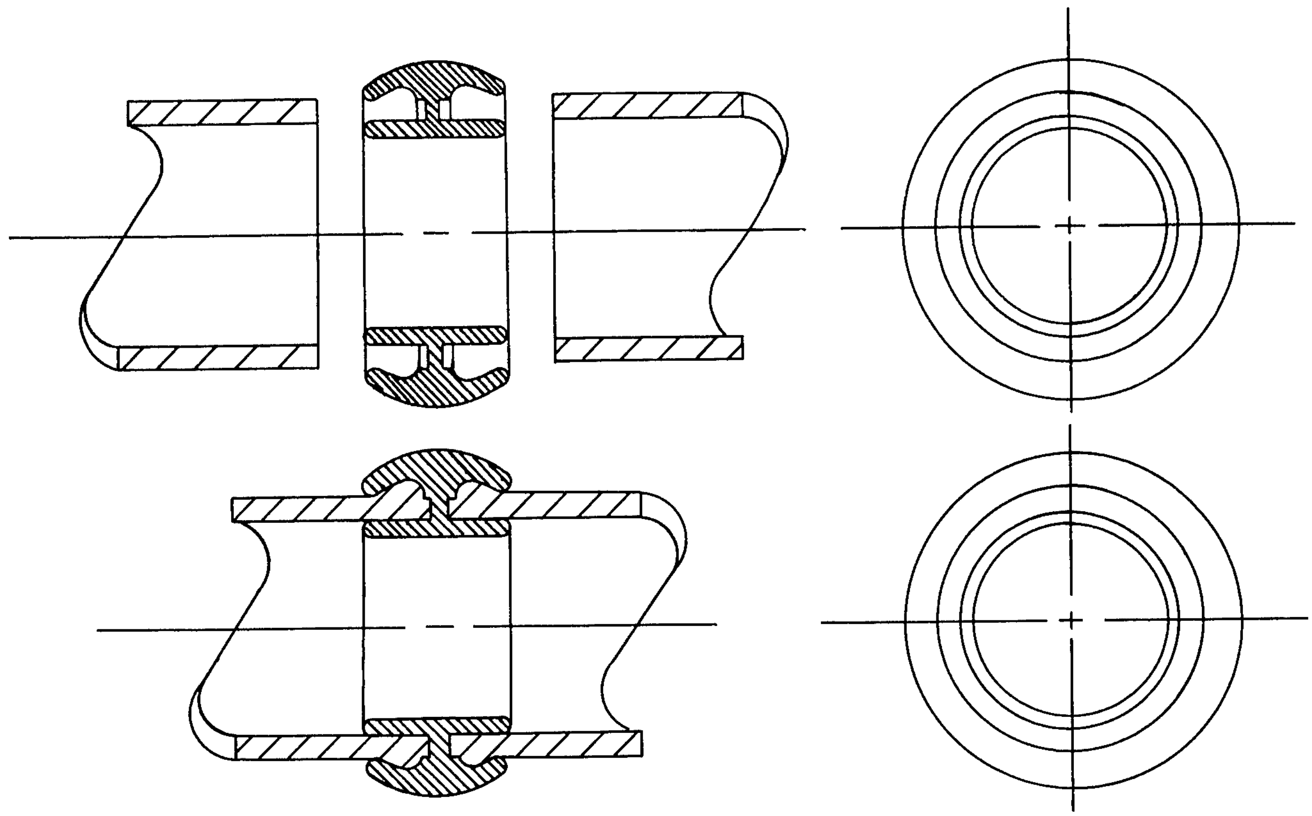

Figure 8.--Pipe connection.

## CONCLUSIONS

The seven applications set forth in this report represent areas where the technique might result in immediate design improvement. They show that this fastening concept may serve as the basis for new generic fastening systems and that other embodiments for other uses may be conceivable. It was further concluded that engineering effort on any of these and many other possible applications might result in new commercial products or processes based on this NASA-developed technology.



NASA-Langley, 1965